REF	QUESTION	DISPOSITION	✓
3.16 (e) 3.16 (f)	See IWG1 Doc No. 13. (USA/17 SUP: Delete (e) and (f) to simplify.	IWG1 agrees with USG proposal.	
3.17	See IWG1 Doc No. 13. (USA/18 MOD: Specify the date appearing on the face of the Weekly Circular.)	IWG1 agrees with USG proposal.	
3.27	See proposed USG changes [Doc No. ?]. Also, suppress VGE note 6 re Rules of Procedure and suppress the phrase "and the Bureau."		
3.40.1	Discussed but not resolved.		
Art. S10	USG is opposed to adoption of ARTS10 (procedures for modifying plans) as part of Radio Regulations, and is proposing to suppress it and make it a resolution.	IWG1 agrees with USG proposal	
5.7.1	See IWG1 Doc No. 17. (Comsat proposal regarding typical earth stations.)		
5.8	"When an administration . . ." should be changed to read "When any administration . . ."	Agreed	

REF	QUESTION	DISPOSITION	✓
5.14; VGE Note 10	Discussion to the effect that Bureau should retain the notice; some action should be taken to inform administration submitting the notice. IWG1 has not proposed specific language.		
5.15 (e)	To be addressed by those members of IWG1 who are concerned about Plans.		
5.22	USG will recommend suppression. No document yet.		
5.29	USG will recommend Mod. or suppression. No document yet.		
7.1 to 7.4	Section I ("Assistance to Administrations by Bureau"), consisting of Nos. 7.1 to 7.4, should be suppressed as unnecessary.	Agreed	
ART S14	Procedures for review of findings or other decisions of Bureau. To be reviewed and investigated further by IWG1, especially No. 10.6 with regard to the procedural rights of other affected administrations whose interests are adversely affected but who did not request the review.		

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APPENDIX B

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FCC INDUSTRY ADVISORY COMMITTEE

FOR THE

ITU 1995 WORLD RADIO COMMUNICATION CONFERENCE

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FINAL REPORT

OF

INFORMAL WORKING GROUP 2

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Donald M. Jansky
Chair

Kathryn A. Martin
Vice Chair

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INFORMAL WORKING GROUP 2 - MSS BELOW 1 GHZ

FINAL REPORT

1. INTRODUCTION

At the initial FCC Industry Advisory Committee (May 31, 1994) in preparation for the 1995 World Radiocommunication Conference, the FCC created several informal Working Groups to consider the various aspects of the previously established WRC 95 agenda. The second working group, IWG-2, was created to draft and justify, for the IAC's consideration, recommendations for U.S. proposals and positions on:

1. spectrum requirements for the mobile-satellite service (MSS) below 1 GHz;

2. additional frequency bands that could be allocated to MSS below 1 GHz;

3. technical and operational constraints associated with the presently and potentially allocated frequency bands below 1 GHz to MSS with a view toward facilitating the use of these bands;

4. addition(s) to/modifications of the relevant Radio Regulations

5. resolutions and recommendations, if any, of World Administrative Radio Conferences which are relevant to the aforementioned items 1, 2 and 3.

As part of its Terms of Reference, IWG-2 is required to support its recommendations for U.S. proposals and positions by narrative text that indicates (a) the amount, and basis for determination of spectrum needed, (b) the placement in the spectrum of additional MSS allocations (c) the unmet spectrum requirements for MSS below 1 GHz, if any; (d) the appropriate sharing criteria; (e) the time frame associated with any unmet spectrum requirements and any recommendation that may be required of existing services; and (f) any consequential changes needed to the international Radio Regulations in order to implement the suggested changes/allocations.

Mr. Donald Jansky was appointed Chairman of the Working Group; Ms. Kathryn Martin was appointed Vice-Chairman; and Ms. Kristi Kendall was appointed the FCC Contact.

In order to undertake its studies according to the requirements of its terms of reference, IWG-2 adopted a Work Program for IWG-2 which consisted of the following elements:

Agenda Item 2.1 (a)

Allocated Spectrum - IWG-2 was requested to evaluate and develop new or modify existing technical constraints, if necessary, on spectrum allocated to MSS Below 1 GHz on a primary basis (specifically 137-138 MHz, 148-149.9 MHz, 149.9-150.05 MHz and 400.15-401 MHz) with a view toward enhancing its use for non-voice, non-geostationary (NGSO) MSS, including an analysis of all footnotes, resolutions, recommendations, and provisions of the Radio Regulations applicable to this spectrum.

Technical and Operational Criteria Concerning Existing Services - Reviewing any dates associated with certain parts of the Radio Regulations, coordination triggers, classes of allocation and sharing criteria available within the Radio Regulations, ITU-R Bureau rules of procedure and ITU-R Recommendations to determine adequacy for use with the NGSO MSS. In addition, IWG-2 was given the option of considering improvements to existing secondary MSS allocations to facilitate their use for NGSO MSS and providing any other sharing criteria required to maintain compatible operations between the planned NGSO MSS and other radio services operating in the allocated frequency bands.

Agenda Item 3(d)

New Allocations - Estimate additional bandwidth requirements for NGSO MSS and identify preferred frequency bands with a view toward obtaining limited primary or secondary allocations in 1995. To this extent, provide analysis of any necessary technical and/or operational criteria for other services in candidate bands. IWG-2 was also requested to determine the ability of several NGSO systems to share spectrum and the impact this sharing ability has on the bandwidth requirement, and indicate projected time frames within which new allocations will be needed and existing services can be reaccommodated.

Agenda Item 5

Regulatory Provisions - Together with IWG-3 (MSS Above 1 GHz), IWG-2 was requested to develop any regulatory provisions necessary to coordinate and implement NGSO MSS below 1 GHz with existing services. To this end, it should evaluate Resolution 46 and other Regulatory provisions with a view toward defining any

changes that will be beneficial to the development of the U.S. NGSO MSS industry.

The Working Group also examined the question of future agendas, and plans to provide its recommendations for future agenda items to the IAC.

IWG-2 met ten times to undertake its studies. The IWG had full participation from a variety of industry representatives and several observers from U.S. Government agencies.

The following is an interim report of its activities and findings. The next four sections explore the questions regarding Requirements, Allocations, Sharing Criteria and Resolution 46. The IWG also considered many foreign views in its deliberations, and section 6.0 provides an analysis of relevant international views to provide a context from which the IWG has made its recommendations. IWG-2's recommended proposals and positions are contained within section 7.

2.0 Requirements

At WARC'92 1.525 MHz of spectrum was allocated Primary for space-to-Earth operations and 1.9 MHz of spectrum was allocated Primary for Earth-to-space operations for a total of 3.425 MHz. An additional 6.475 MHz of spectrum was allocated Secondary for up and downlinks, with 150 KHz of this spectrum (149.9-150.05 MHz Earth-to-space) to be changed to Primary allocation effective January 1, 1997. Six MHz of this Secondary allocation is in the 300 MHz band, which according to the U.S. allocation Table (including footnotes) the U.S. Government spectrum is not available for domestic commercial MSS services. Footnotes to the WARC-92 Primary allocations afford special protection to existing services operating under Primary status in all spectrum allocated to non-geostationary MSS.

In January 1993, the Federal Communications Commission (FCC) adopted the WARC-92 spectrum allocations in the United States with one addition. The so-called upper "Transit" band at 399.9-400.05 MHz (150 KHz) was allocated as a Primary uplink effective January 1, 1997.

In October 1993, the FCC adopted U.S. domestic regulations governing the licensing and provision of the new MSS services and limited the new service to non-voice non-geostationary (NGSO).

In November 1994, five new applications (in addition to the three applications previously filed with the Commission) were filed to provide below 1 GHz non-GSO MSS. Two proposed modifications requiring additional spectrum were also filed. Based on detailed market studies conducted by U.S. organizations planning and constructing MSS below 1 GHz systems and independent

studies, the demand for the new low-cost, ubiquitous services is expected to be large and fast growing. See Annex 1, Studies of CTA, Final Analysis, STARSYS and LEO one. These studies indicate a capturable market in North America in excess of 40 million users by the year 2000. However, in-depth technical sharing analyses and on-orbit measurements of spectrum usage and radiated power show clearly that the allocated spectrum is heavily used by the existing terrestrial services, and the less-used spectrum will be insufficient to accommodate all ITU-BR published systems. It is unlikely that the presently allocated MSS spectrum below 1 GHz will allow all pending U.S. applicants and licensed systems to operate simultaneously while providing reliable and commercial grades of service.

2.1 Demand for NGSO Services

Although NGSO spectrum is limited, market demand is expected to be high. Studies to determine demand for the new NGSO services in the U.S. and internationally have been in progress for over five years. The outlook for these services resulted in worldwide support for allocations and licensing of initial systems. Projections for subscriber demand are based upon the following characteristics of NGSO services:

- Low-Cost Subscriber Equipment and Services Resulting From use of VHF/UHF Frequencies, Data Transmission Only, and Low Investment Requirements
- Two-Way Ubiquitous Global Communications Capability for the First Time Combined with Low Subscriber Costs
- Enabling technologies such as Pocket Portability and Long Battery Life, Two Fundamental Requirements in Numerous Applications
- Interconnectivity and Compatibility with e-Mail Systems
- Complementary with Mobile Computers and GPS Devices

In addition to the characteristics of MSS services below 1 GHz, other key factors are driving demand for the new services:

- Enormous growth in computer availability and usage that has demonstrated to millions of people the benefits of alphanumeric communications and has made people comfortable with use of keyboards. In the U.S. there are an estimated 35 million people connected to an e-mail service. Over 10 million people around the world are connected to the Internet, 1,000 computers are added each day to the Net, and traffic is growing at 10 percent a month.

- Simultaneous explosion in the use of mobile communications services with the resulting demand for mobile computing and e-mail services. In the U.S. over 40 million persons work on a regular basis away from a fixed site.

- Growth in awareness of the benefits of mobile communications to business and for personal convenience and urgent, high priority messaging. This is manifested in the rapid growth in cellular subscribers in the U.S. to over 16 million and in paging subscribers to almost 20 million.

- The urgent demand for data communications in lesser developed countries that do not have extensive land-line communications infrastructure.

- Recognition among commercial shipping companies and truck fleet operators that they can achieve substantial efficiencies by using low-cost MSS tracking, identification and messaging services virtually anywhere around the globe.

- The growing need for environmental data collection for numerous governments, agencies, and individual companies.

- A rising theft problem of high value cargo and vehicles in virtually every country.

- The ability of MSS systems below 1 GHz to provide data messaging, positioning, and file transfers to areas around the world by reusing small amounts of spectrum as the satellites circle the Earth.

MSS services are widely perceived as being the long-sought, practical way to fill the last large gap in the worldwide telecommunications network---convenient two-way communications capability everywhere on Earth at affordable prices. Subscriber communication equipment is expected to be priced between $100 and $400 retail. Service pricing is expected to range from as low as $25 per year to $100 per month depending on the type of service and usage.

2.2 Expected Growth

The view that NGSO MSS services will find widespread market acceptance is supported by the number of systems that have been announced around the world or are known to be at some stage of development. In the U.S., in addition to the three applicants included in the first processing round, four companies have requested experimental authority to use the allocated spectrum,

and one has received such authority. A second processing group was initiated by the FCC in late 1994 resulting in five new system proposals. Outside the U.S., system plans have been announced in twelve countries including Mexico, Brazil, Russia, India, France, Italy, Germany, Australia, Korea, Belgium, Tonga, and Uganda.

Detailed discussions with hundreds of potential user groups around the world have substantiated the requirement for MSS services operating below 1 GHz and have led to significant investments in system development, construction, and pre-operational marketing. Initial commercial services are scheduled to begin in 1995.

Based on independent studies[1] of potential demand and data released by organizations planning NGSO systems, worldwide demand is expected to reach approximately fifty million subscribers by the end of the decade. Services will include emergency/SAR services, data acquisition and monitoring, tracking and messaging. NGSO MSS systems are projected to account for 20 percent of the worldwide wireless e-mail market by the year 2003 which is valued in total at over $5 billion. These projections do not include potential requirements for OEM automotive installation which could increase the underlying demand by tens of millions of subscribers in the U.S. alone.

It is estimated, based on capacity studies using conventional busy hour analyses, that the allocated spectrum may be sufficient to meet demand in the U.S. through 1999. If this is the case, about 1.5 million U.S. subscribers will be serviced while occupying only 3.425 MHz of Primary spectrum or almost 500,000 subscribers per megahertz. Replacement systems that would be launched in the 1999 to 2003 period would be severely

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[1] Publicly Available References:

- Wireless Electronic Mail & Facsimile Markets, Worldwide, November 1993, International Resource Development Inc.
- The Market for Mobile Satellite Services: Prospects for LEOs and GEOs, June 1994, Leslie Taylor Associates
- ISSO Conference, Washington, D.C., June 1994, Orbital Communications Corporation
- Developments on the Mobile Data Communications Market, June 1992, Arthur D. Little Inc.
- Portable Computers & Wireless Communications, Third Quarter 1993, DataComm Research Company

restricted in their ability to increase capacity within the existing allocations, notwithstanding advances in technology.

It is considered likely that demand for non-GSO MSS below 1 GHz services will grow at the exponential rates experienced by other mobile services, such as cellular telephones. Moreover, addition of OEM automotive applications would be expected to increase these projections by more than ten times.

Experience suggests that approximately 5 years is required to fully implement systems after spectrum is allocated. This long lead time is due to many factors. For example, fundamental decisions related to technology design and development must be made in the early stages of a project. These decisions cannot be made without identification of specific frequency bands, assurance that spectrum will be available in the specified bands, and a clear understanding of what inter-service and intra-service sharing considerations may apply. The amount of spectrum available and the frequency bands will also determine the number of satellite systems and system subscribers/customers that can be supported. This will have a direct impact on the system's technical design, business plan and, ultimately, the ability to finance these systems. Thus, to meet demand by the year 2000, additional spectrum will be needed by 1995.

2.3 Additional Spectrum Requirements to NGSO MSS Services Operating Below 1 GHz

As discussed, additional spectrum allocations need to be made at WRC-95 to meet growth requirements. Additional allocations must take account of regulatory, planning and construction spans. Typically there is a minimum period of five or six years from the time allocations are made at an ITU radio conference and operational availability of a new system using the new allocations. To accommodate spectrum and schedule requirements, an allocation must be made at WRC-95.

It is assumed that the subscriber-per-megahertz of bandwidth ratio projected for the initial NGSO systems is constant through the planning period (500,000 per MHz) and that North American requirements drive spectrum allocation. Consequently, additional worldwide Primary allocations of 7-10 MHz will be required to accommodate our operators and meet consumer demand through the year 2000.

It is likely however that these numbers will be much higher. Because MSS systems operating at higher frequencies require far more expensive space segments and subscriber equipment than do those operating at lower frequencies, subscribers will inevitably demand increased functionality from MSS service providers operating below 1 GHz. This means capability for longer messages, value added information services and other

Table 1.0
International MSS Allocations Below 1 GHz

MSS allocation and status (MHz)	Quantity of Spectrum (MHz)	MSS FN	Other Services and Footnotes
137-137.025 co-primary (s-E)	0.025		SPACE OPERATION (s-E) MET.SAT (s-E) SPACE RESEARCH (s-E)
137.025 - 137.175 secondary (s-E)	0.15	599A 599B	Fixed Mobile except aeronautical mobile (R)
137.175 - 137.825 co-primary (s-E)	0.650		
137.825 - 138 secondary (s-E)	0.175		596 597 598 599 599A
148 - 149.9 co-primary (E-s)	1.90	599A 608A 608C	FIXED MOBILE (except aeronautical mobile (R) - Region 1) 608 608A 608C
149.9 - 150.05 (LMSS) (E-s) co-primary after 1 January 1997	0.15	599B 609B	RADIONAVIGATION SATELLITE 608B 609 609A
235 - 322 and 335.4 - 399.9 secondary	151.5 (Article 14) Resolution 46 does not apply	641	FIXED MOBILE 641 641A
312 - 315 secondary (E-s)	3.0 (Article 14)	641A	FIXED MOBILE 641 641A
387 - 390 secondary (s-E)	3.0 (Article 14)	641A	FIXED MOBILE 641 641A
400.15 - 401 co-primary (s-E)	0.85	647B	MET.AIDS MET.SATELLITE (s-E) SPACE RESEARCH (s-E) SpaceOperations (s-E) 647 647B
806 - 890 primary (Region 2 only)	84 (Article 14) Resolution 46 does not apply	700	FIXED MOBILE

telecommunications services. The existing allocations are unable to support transmission of longer messages, data/information files, facsimile and similar services. Thus, future spectrum allocations should more realistically provide for expansion of services that MSS systems can offer in these bands.

3.0 Existing MSS Allocations Below 1 GHz

This section describes the situation regarding MSS allocations below 1 GHz and identifies possible allocations which might be considered for future proposed additional MSS allocations below 1 GHz.

3.1 Existing Allocations

The Table below indicates the footnotes pertaining to international MSS allocations below 1 GHz. It also shows related frequency bands and certain regulatory provisions.

As indicated above, the 3.42 MHz of bandwidth allocated to MSS below 1 GHz on a Primary basis (the Base-Allocation) will be insufficient to accommodate present systems. To compound this problem, the Base-Allocation, which must provide for both subscriber and feederlinks in-band, is shared with other services also allocated on a Primary basis. To protect these other services, the following international and domestic restrictions, both operational and regulatory, have been imposed upon MSS systems below 1 GHz.

. 148-149.9 MHz Uplink (1.9 MHz)

- U.S. Footnote 323 establishing mobile terminal transmission duration, duty cycle and pfd limitations
- Non-Interference Sharing with Tens of Thousands of Existing Users Worldwide
- No Always-Clear Spectrum Sub-Bands
- -150 PFD Limit Outside National Border

. 137-138 MHz Downlink (675 KHz)

- PFD Coordination Threshold Limit
- MetSat PFD Thresholds for Coordination (Affects Co-Frequency CDMA System)

. 400.15-401 MHz Downlink (850 KHz)

- Existing/Planned Systems Restrict MSS Usage in 710 kHz of the 850 kHz available

The spectrum allocated on a Secondary basis at 137-138 MHz (downlink) is encumbered by PFD coordination threshold criteria, beyond the -125 dB limit, for protection of the MetSat Primary services that will require coordination by any type of NGSO system desiring to operate in the Secondary allocation.

In the bands 225-400 MHz the uses include tactical operations (joint U.S. and European allies); and air-ground, air-air and ground-ground communications. In the U.S., 235-322 MHz and 335.4-399.9 MHz are allocated MSS subject to Article 14 coordination. Footnote G100 makes this MSS allocation available for military use only in the U.S.

The net effect of these restrictions is to limit further the number of NGSO systems that can operate in the spectrum allocated to NGSO service.

3.2 Sharing in Existing MSS Allocations Below 1 GHz

During WARC-92 certain constraints were placed on the Low Earth Orbit Mobile Satellite Service (LEO MSS) < 1 GHz allocations to assure protection of the existing users of the allocated bands. These constrains took the form of footnotes to the allocations containing specific technical language to protect the fixed and mobile operators in the 148.0-149.9 MHz, 137-138 MHz and 400.15-401 MHz bands. Radio astronomy operations in nearby bands were also protected.

3.2.1 Existing Services

3.2.1.1 137-138 MHz and 400.15-401 MHz Bands. (Downlink bands)

FN 599A

- Use of the 137-138 MHz band by the mobile satellite service is subject to the coordination and notification procedures set forth in Resolution 46(WARC-92). However, coordination of a space station of the mobile satellite service with respect to terrestrial services is required only if the power flux-density produced by the station exceeds -125 dB(W/m^2/4 kHz) at the earth's surface.

- Administrations shall take all practical steps to protect the radio astronomy service in the 150.05 to 153 MHz band and the 406.1-410 MHz band from harmful interference from unwanted emissions.

Comment: NGSO MSS systems can comply with both the -125 dB(W/m^2/4 kHz) coordination trigger and the protection of the radio astronomy service.

3.2.1.2 148.0-149.9 MHz Band. (Uplink band)

FN 608A

- Use of the band by the mobile satellite service is subject to the application of the coordination and notification procedures of Resolution 46.

- The mobile satellite service shall not constrain the development and use of fixed, mobile and space operation services in the band 148-149.9 MHz.

- Mobile Earth stations in the MSS shall not produce pfd in excess of -150 dB(W/m^2/4 kHz) outside of national boundaries.

Comment: The 148.0-149.9 MHz band is one band in which existing users share available spectrum, and is comparable to other bands being considered for NGSO MSS use.

Existing studies demonstrate that NGSO MSS systems have characteristics which permit sharing with the fixed and mobile systems in the 148.0-149.9 MHz band. However, the restriction of -150 db(W/m^2/4 kHz) outside national boundaries has operational and regulatory difficulties. As written, the different systems could require up to 200 kilometers separation for the mobile signal to attenuate to the -150 dB(W/m^2/4 kHz) level. This would make it impossible to expect compliance. In addition, no proper propagation model advice has been provided to the ITU-R, nor has a procedure for how to proceed if the pfd limit is exceeded been identified. It is considered that a "threshold" for coordination is a more appropriate method for insuring that transmissions from mobile terminals across borders can be accommodated by countries within a specified distance of one county's borders. Such a method has been developed and should be proposed as a substitution for the approach in this footnote. (See Annex 2), Draft New Recommendation ITU-R-M, [Doc.8/46], "Method for Determining Coordination Distance Between Ground Based Mobile Earth Stations and Terrestrial Stations Operating in 148-149.9 MHz Band."

FN 609C With all of these sharing techniques IWG-2 agrees with the CPM that countries should be encouraged to examine their continuing need for their name on this footnote, consistent with the recommendation of the VGE to reduce country footnotes.

3.2.1.3 149.9-150.05 MHz Uplink Band

FN 608B The pfd limit of -150 dBW/m^2/4 KHz outside national boundaries should be replaced with a coordination method for use by national authorities. There are both operational and regulatory difficulties with this pfd limit. Operationally it is very difficult to limit the use of mobile handset terminals within an administration such that this pfd limit is not exceeded outside its national boundaries. In addition no advice is given to the BR on how to calculate this pfd level.

In view of the difficulties in implementing this limit, it is recommended that the coordination threshold distance calculation method described above in RR 608A also be considered for coordination between the Land Mobile Satellite Service and other services sharing the band.

Technical characteristics of the land mobile-satellite service are not unique and a generic MSS allocation may be appropriate.

3.2.2 Sharing With Other Co-Primary Services in the Existing Bands

In addition to the specific restrictions listed in the ITU frequency allocation footnotes, LEO MSS < 1GHz systems must be able to share the allocated spectrum with other existing co-primary users in each band. Efforts are underway to develop the necessary criteria. Currently, ITU-R Study Group 7C and WP 8D are developing revised sharing criteria for the meteorological satellites in the 137-138 MHz and 400.15-401 MHz downlink bands based on the characteristics of the METSAT systems.

3.2.2.1 Sharing with METSATS

Interstitial FDMA LEO MSS systems are able to share with METSATS simply by avoiding the areas of METSAT use in the band. Since spread-spectrum system signals cover most of the bandwidth at 137-138 MHz and hence must operate in the same channels as METSAT, these systems must use a combination of low pfd at ground level and cross-polarization of the satellite downlink signals to achieve the necessary signal isolation to avoid interference to the various METSAT receivers. In the 400.15-401 MHz band, LEO MSS systems share by avoiding the areas of the band intended for use by METSATS.

3.2.2.2 Sharing with Space Operation, Space Research, and Meteorological Aids

LEO MSS < 1 GHz systems can share with these occasional co-primary users of the downlink bands through the use of one or a combination of sharing techniques. Channel avoidance, low pfd's, band segmentation, and cross polarization can be utilized in different combinations to avoid harmful interference to existing co-primary systems in the allocated bands.

3.2.3 Sharing With Other LEO MSS Users

In order to share the small amount of spectrum allocated to LEO MSS < 1 GHz at WARC-92, the sharing arrangements for common use of the frequency allocations can be based on the requirements and the characteristics of different LEO MSS < 1GHz systems. In the uplink band, band segmentation by type of system permits both FDMA and spread-spectrum transmission techniques to share the uplink band. In the downlink bands, a combination of sharing techniques can be used: channel positioning, cross polarization, and low pfd levels. In this case, systems are required to share

with several established co-primary users of the bands as well as with other LEO MSS users, and sharing techniques need to be judiciously selected accordingly.

3.2.4 Ability of NGSO MSS Systems to Operate in the Presence of Existing Users

Table 2 summarizes the sharing issues in existing MSS allocations below 1 GHz bands.

TABLE 2

Sharing Issues in Existing MSS Allocations below 1 GHz

	Narrow-Band	Wideband
FIXED and MOBILE (148-149.9 MHz)	Combination: - Dynamic channel avoidance - Low duty cycle - Brief message duration - Geographical separation	Combination: - Low output power density - Brief message duration - Low data rate - Filtering at satellite - Geographical separation
FIXED and MOBILE (137-138 MHz) (400.15-401 MHz)	Ground level pfd below -125 db (W/m^2/4 kHz) per FN 599A	Ground level pfd below -125 db (W/m^2/4 kHz) per FN 599A
METEOROLOGICAL SATELLITES (137-138 MHz) (400.15-401 MHz)	Band segmentation	Combination: - Low pfd at ground level - Cross polarization - Adaptive filter at satellite
SPACE OPERATIONS SPACE RESEARCH (137-138 MHz)	Channel avoidance	Combination: - Low pfd - Cross polarization
SPACE RESEARCH (400.15-401 MHz)	Channel avoidance	Combination: - Low pfd - Cross Polarization
METEOROLOGICAL AIDS (400.15-401 MHz)	Channel avoidance	Combination: - Low pfd - Cross polarization
OTHER MSS SYSTEMS (uplink)	- Band segmentation for spread spectrum systems - Channel avoidance for FDMA systems - Geographic separation	- Band segmentation for FDMA systems - Spectrum sharing for other SSMA systems
OTHER MSS SYSTEMS (downlink)	Combination: - Channel locations - Cross Polarization - Band segmentation	Combination: - Low satellite eirp density - Cross polarization - CDMA - Band segmentation
OTHER MSS SYSTEMS (400.15-401 MHz)	Band segmentation	Band segmentation
RADIOASTRONOMY	Combination -Filtering -Bit Shaping -Low pfd	Combination -Filtering -Bit Shaping -Low pfd

In general, NGSO MSS < 1 GHz systems use either the FDMA, fixed FDMA or spread-spectrum approach for uplink transmissions from the ground terminals to the satellite. FDMA NGSO MSS systems are dependent upon finding vacant channels so as to avoid creating interference to, or receiving interference from fixed and mobile users in the uplink band (148.0-149.9 MHz). Because FDMA systems function only in the presence of temporarily vacant channels, their effective operation is wholly dependent upon the band use by the existing systems. Because of these built-in characteristics of the LEO MSS < 1 GHz Systems, they are considered "permissive entry" type systems which operate without harmful interference to existing users. Fixed channel FDMA systems will depend upon well surveyed locations and directional antennas to avoid interference to and from existing fixed and mobile users, but these operations are not considered "mobile".

Spread-spectrum systems mobile terminals transmit across a wide bandwidth, and therefore must rely upon a very low power output to avoid harmful interference to the more powerful voice channels of the fixed and mobile users. However, spread-spectrum systems are susceptible to multiple large powered transmissions within the same bandwidth, and must have a sufficiently robust system to remain effective in those conditions. Furthermore, spread-spectrum systems using a satellite transponder must be able to process the voluminous and strong fixed and mobile uplink signals at the satellite to prevent their retransmission into the downlink band in such a manner as to avoid causing harmful interference to itself and other systems in the downlink band. The spread-spectrum systems are therefore also dependent upon available use conditions in the band for effective operation.

4.0 Additional Allocations

4.1 Near Term Requirements

Identification of specific frequency bands for MSS below 1 GHz MSS is a high priority. Selection criteria and candidate bands for MSS below 1 GHz MSS allocations have been identified through the ITU working groups and IAC processes.

Further work clearly needs to be done in order to identify 7 to 10 MHz of spectrum within the candidate bands. This 7 to 10 MHz need not be contiguous spectrum. Uplink and downlink spectrum may be (and is preferably) allocated in different bands. Ideally, a minimum of 1 MHz band segments (up to 10 MHz) for the service links is required for optimal operation and sharing by the proposed U.S. systems.

In the Second NOI, the Commission directs parties to consider both government and non-government spectrum. In the U.S., MSS below 1 GHz NGSO MSS proponents have undertaken a preliminary analysis of frequency bands that are potentially suitable for the MSS below 1 GHz NGSO MSS, and are taking steps to evaluate frequency usage in specific bands in order to determine the optimal allocation in cooperation with government and private users of the relevant bands.

4.2. Selection Criteria

A number of factors must be applied to the selection of frequency spectrum for non-GSO MSS allocations. These include the following.

4.2.1 Worldwide Allocation. In general, the frequency allocation must be useable around the globe in a consistent manner in order for all countries to be able to access this service on an equal basis. NGSO-MSS are inherently global systems in that low earth orbiting (LEO) satellites can provide service almost anywhere on the Earth. It is therefore necessary to acquire allocations that can be used over all ITU regions and not simply in one administration or another.

4.2.2 Frequencies Below 1 GHz. The frequency range is also critical because the market niche for MSS below 1 GHz NGSO MSS is low-cost data transmission that largely depends upon the availability of an inexpensive mobile user terminal. The effective frequency bands for MSS below 1 GHz NGSO MSS therefore lie between 100 MHz and 1 GHz, with the most desirable bands from a cost and technical standpoint between 100-500 MHz.

The practical lower limit of the spectrum is roughly 100 MHz. Below this point, the high power density of environmental noise and the effects of the magnetosphere preclude low cost, reliable service. The upper end of desirable spectrum is a function of both Doppler shift and transmission power requirements. Doppler shift is an inevitable consequence of LEO satellite operations where the changing range to the user results in direct change in frequency. At higher frequencies, the amount of Doppler shift increases, adversely impacting the receiver design and cost. In addition, since NGSO-MSS operations typically use fixed gain antennas at both ends of the link, the use of higher frequencies results in the need to supply higher output power levels for a given error rate. Based on these